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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

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RADIO RESEARCH BOARD.

SUB-COMMITTEE ON RADIO TELEPHONY.

REPORT.

Presented to Parliament by Command of His Majesty.

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RADIO RESEARCH BOARD.

SUB-COMMITTEE E. (RADIO TELEPHONY).

Admiral of the Fleet Sir Henry B. Jackson, G.C.B., K.C.V.O., F.R.S., M.I.E.E. (*Chairman*).
Professor C. L. Fortescue, O.B.E., M.A., M.I.E.E.
Professor G. W. O. Howe, D.Sc., M.I.E.E.
Major A. G. Lee, M.C., B.Sc., A.M.I.E.E.
Secretary: Mr. O. F. Brown, M.A., B.Sc.

Note.—Major A. G. Lee (General Post Office) had to proceed to India in connexion with the Imperial Wireless Chain during a part of the time that the Committee was sitting, and his place was taken during his absence by Mr. E. H. Shaughnessy, O.B.E., the Post Office representative on the Radio Research Board.

We were appointed by the Radio Research Board on the 4th October 1921, as a result of the following resolution of the Imperial Conference :—

> "That the Radio Research Board be asked to investigate the subject of Wireless Telephony and to report on its development whether governmental or private.
>
> "That the Postmaster General shall supply to the Governments of the Dominions and India technical reports showing its position and possibilities."

We have held eight meetings and have completed our examination of the present position of Radio Telephony in this country. In this work we have been assisted by witnesses from the three Fighting Services, and from Marconi's Wireless Telegraph Company, Ltd., and the Radio Communication Company, Ltd., the following gentlemen giving evidence :—

Major J. R. Erskine Murray, D.Sc. (Air Force) (Instrument Design Establishment).
Lieutenant-Colonel A. G. T. Cusins, C.M.G., R.E. (Army) (Signals Experimental Establishment).
Mr. C. A. Irving (Navy) (H.M. Signal School, Portsmouth).
Mr. C. S. Franklin (Marconi Company).
Captain H. J. Round, M.C. (Marconi Company).
Captain N. C. Lea (Radio Communication Company).

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We have the honour to submit the following report.

1. *Relative merits of Wireless Telegraphy and Radio Telephony.*—All the witnesses we have examined agree that for the transmission of a specific message over any distance—long or short—the Radio Telephone is greatly inferior to the Radio Telegraph in accuracy, speed, and cost; and is likely to remain so. The witnesses agreed that the articulation of the best Radio Telephone installations known to them compares favourably with that over a trunk land line, but all agreed that it is necessary to repeat or spell unusual words or proper names and repeat figures. Our witnesses agreed also that the skilled personnel necessary to work a large Radio Telephone installation or a number of small ones is approximately that necessary to maintain similar Radio Telegraphy stations.

We consider, therefore, that the spheres of utility of the two systems are as separate and clearly defined as those of land line Telephony and Telegraphy.

2. *Possible applications of Radio Telephony.*—With land line Telephony there are local connexions—often many thousands in one locality—and trunk lines. Considerations of mutual interference—quite irrespective of the greater convenience of land lines—rule out the Radio Telephone for local connexions. We consider therefore, that the most important applications of the Radio Telephone on a commercial scale are as connecting links between ordinary land line telephone systems either at great distances (*e.g.*, between Europe and America), or at medium or short distances between islands; or as a means of communication with isolated posts, lightships, etc., where the laying of a telephone cable would be expensive or impracticable; or possibly as short links in land trunks across swamps or virgin forests where land lines are difficult to maintain; or again, broadcasting intelligence and music for the general benefit of the community is a further example of its commercial utility.

There are occasions, also, usually in the case of very short distances, when personal communication between Principals is essential and secrecy is unimportant. In these cases the use of a Radio Telephone, even independent of land line systems, may be very convenient. The Fighting Services have directed their development of Radio Telephony almost entirely to meet such demands, and have developed efficient non-secret installations suitable for their special requirements. For example, the Air Force make use of Radio Telephony daily in the navigation and landing of aircraft; and it has been developed to a certain extent in the Navy for communication between particular officers of ships in close company. The need for similar communication may also arise commercially. For example, when a ship is approaching harbour, direct communication between the Master and the Port Authorities with regard to berthing and other matters might effect a considerable saving of time in getting alongside.

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3. *Requirements for a Commercial Service.*—The requirements of any system of telephony for commercial success may be summarised as follows :—

(*a*) The articulation must be reasonably good.

(*b*) It must be possible for subscribers to be connected —either during the whole day or during specified periods— without excessive delay.

(*c*) The running and maintenance costs must be such that without excessive charges the Service can pay its way.

(*d*) Some degree of secrecy must be provided.

For successful operation, a Radio Telephone installation must satisfy these requirements to the same extent as a land line system. With regard to (*a*) the Radio Telephone must give at least as good articulation as existing land lines give. To satisfy (*b*) sufficient power must be used to overcome all interference from other signalling or from atmospherics during the whole 24 hours (or, where a limited service is all that is required, during such hours as the service is open to the public). But in order to comply with (*c*) this power must not be so large that running and maintenance costs are excessive. The interference of atmospherics is very variable both in respect of locality and season, and in certain localities communications may be interrupted from this cause for hours or days, even when very high transmitting powers are used. As regards (*d*) the ideal, of course, is absolute secrecy; but a service might be considered commercially possible if the interception of a conversation required costly and elaborate apparatus needing skilled adjustment, thereby making interception a matter of great difficulty and impossible with ordinary radio telegraph receiving instruments.

Furthermore, where the Radio Telephone is a link between land line systems it must provide for direct connexion to these systems so that two subscribers may be able to communicate from the telephone installations in their own homes or offices without having to travel to special radio stations to carry on their conversation.

4. *Grouping of the Evidence.*—The evidence we have collected as to the feasibility of Radio Telephonic Communication divides itself into three parts—evidence on the practicability of communication over (*a*) long distances of the order of 3,000 miles or more, (*b*) medium distances of the order of, say, 1,000 miles, (*c*) short distances of the order of 200 miles.

5. *Long Distance Radio Telephony.*—With regard to long distances it appears that, under those favourable conditions which are experienced for a few hours daily in most places, it is technically possible for speech to be transmitted through the ether to any range up to the distances which are now judged feasible for reasonable Radio Telegraph communication. Thus, given two radio installations of sufficient power, a person could carry

on a conversation with another person at these distances provided expense was no object and secrecy was immaterial. Demonstrations have been given, and will probably continue to be given, of the transfer of speech by non-secret methods over distances up to 2,000 miles or more. We believe, however, that no organised experimental work with a view to providing a reasonably secret commercial service over such distances is being carried on or is contemplated either by Government establishments or by commercial firms in this country. We consider that the possibility of establishing satisfactory radio telephone communication on a commercial basis over a distance of 3,000 miles or more is remote.

6. *Difficulties of Long Distance Radio Telephony.*—The reasons for this conclusion may be stated as follows :—

(*a*) The wave lengths most suitable for long-distance Radio Telegraphy are unsuitable with the methods at present in use for Radio Telephony, and telephonic communication would therefore have to take place on wave-lengths which are known to be inefficient for long ranges.

(*b*) The power required for Radio Telegraphic communication for a 24-hour service daily is already very large, and in spite of the improvement in receiving apparatus modern practice favours the use of higher powers for long distance communications than were considered adequate a few years ago.

In consequence of (*a*) and (*b*) above, witnesses variously estimated the powers for Radio Telephone services to be from 3 to 20 times greater than those at present considered necessary for similar Radio Telegraph services over the same ranges. The necessary charge for a conversation would accordingly reach an impracticable figure.

(*c*) No means at present are known by which any appreciable secrecy can be obtained for a conversation taking place at such a range. That is to say, the conversation can be picked up at any Radio Telegraph Station or by any amateur within range, having receiving instruments which can be tuned to the wave length used. (*See also* last sentence of paragraph 9 (*d*).)

(*d*) The interference with other radio communications would be greater than that due to two Radio Telegraph stations communicating over the same distance on the continuous wave system, owing largely to the increased power.

(*e*) Radio Telephone communication would be exposed to atmospheric interference, and the interference of other radio stations, to a greater extent than Radio Telegraph communication over the same distance. With a long distance Radio Telegraphic service it is possible in the event of temporary adverse conditions to hold back traffic for half an hour or an hour without serious results, but with a number of subscribers waiting to use a long distance Radio Telephone, a delay through any disturbance would be most detrimental to the service.

7. *Medium Distance Radio Telephony.*—For medium ranges, we consider that the difficulties as regards a commercial service are practically the same as those for long distances, except for the fact that unless considerations of mutual interference prevailed, the waves which could be used for Radio Telephony would be the same as those which are efficiently used for Radio Telegraphy. We consider, however, that in remote localities where the danger of mutual interference between Radio stations is small and the risk of interception of the conversations by unauthorised persons is slight—either because of the sparseness of population or for other reasons—a Radio Telephone service employing waves of the length used by medium power Radio Telegraphy stations would be possible; provided, always, that the cost of the necessary additional power was not prohibitive. As in the case of the longer distances we believe that no organised experimental work with a view to providing a reasonably secret commercial service is being carried out.

8. *Radio Telephony over Short Distances.*—The position as regards short distance communications is, however, more hopeful. We have learnt that the Marconi Company in this country is experimenting with semi-secret systems with the expectation of placing Radio Telephony on a commercial basis in the near future for distances up to about 200 miles over sea. The representatives of the Marconi Company have kindly furnished us with a complete description of the installations intended for such a service between this country and the Continent, using short wave lengths of the order of 100 metres and a power of 5 K.W. This Company has informed us also of the very promising results of certain experiments carried out by their experts at a range of 90 miles over land using wave lengths of the order of 20 metres. Although this latter line of development appears promising, it must be recognised that the system proposed is only in the experimental stage. Neither of the systems has yet been tested in an actual commercial service.

9. *Extent of the Success of Short Distance Radio Telephony.*—We consider that the conditions requisite for a commercial service as enumerated in paragraph 3 of this report, can be met at the present time in the case of a service over a short range to the following extent:—

(*a*) The articulation is approximately as good as on land lines of similar length.

(*b*) It seems probable that a full 24-hour service could be maintained in most localities.

(*c*) Atmospheric disturbances and, under present conditions, interference by and with other stations are very much less troublesome on the short waves used, so that delays of traffic through these causes are less probable, and the power required is not excessive.

(*d*) Unauthorised reception is made more difficult by the use of short waves, but the conversations can be picked up by special apparatus. In the case of very short waves, instruments of very special design are required; and, moreover, the transmission can be made to some extent directive, *i.e.*, the waves can be made stronger at points on the line joining the transmitter and receiver than at points off that line, thus reducing the area over which interception is possible. In any system, irrespective of distance, the use of different wave lengths for transmission and reception at a given station makes it more difficult for one person to overhear the whole of a conversation.

(*e*) There are no insuperable difficulties in the system being worked satisfactorily in connexion with the ordinary trunk lines, and, as far as subscribers are concerned, the conversation can take place exactly as with the land line system, *i.e.*, the subscriber has not to instal in his office any special apparatus or to manipulate any switches during a conversation.

10. *Note on the Use of very Short Waves.*—It will be noticed that the solution of the practical difficulties of commercial application of Radio Telephony outlined above depends largely on the use of short waves. The system is thus limited to comparatively short ranges, and the achievements of this line of development cannot be extended to Radio Telephonic communication at longer distances without resorting to longer wave lengths with the consequent elimination of the slight degree of secrecy the use of short waves at present gives.

It should be noticed also that the absence of interference on short waves is mainly due to the fact that these wave lengths are not greatly used at present for radio communication. The increased use of such wave lengths by a number of Radio Telephone services would probably cause mutual interference to nearly the same extent as is now experienced on longer wave lengths.

11. *Summary of Conclusions.*—The conclusions of this report may be summarised as follows :—

(*a*) We consider that the development of Radio Telephony for long ranges is in an extremely elementary stage, and we see no line of development which would be likely to lead to its establishment on a commercial basis within a measurable period.

(*b*) For ranges of the order of 1,000 miles, we consider that in certain remote localities, where the interference from atmospherics and other radio communications is not excessive, it would be possible to establish non-secret Radio Telephonic services using waves of the length usually employed by medium power Radio Telegraph stations

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communicating over the same range. The power necessary for Radio Telephony, however, would be much greater than that required for satisfactory communication by Radio Telegraphy over the same distance.

(*c*) For ranges of the order of 200 miles, we consider the position more hopeful, and it seems that the lines of experiment which are being followed will lead to the development in a reasonable time of a system of Radio Telephony which will approach approximately at any rate to the requirements of a commercial system.

(*d*) We cannot, however, recommend the use of radio telephony as a substitute for any other means of telegraphic communication except in those cases where the special requirements can be met in no other economic way; for example, the broadcasting of intelligence of general information where one costly transmitting station supplies a great number of simple, inexpensive receiving stations, seems a practical commercial problem, especially in localities ill-equipped with land lines.

12. *Proposals re future Work of Committee.*—As regards the future work of the Sub-Committee, we can, if desired, examine more fully the position of Radio Telephony abroad. We desire to state, however, that from the general study which we have made of the information published in the technical press, we hardly expect to find that the development of Radio Telephony in foreign countries has been carried much, if any, further than in this country. We can, if desired, recommend to the Radio Research Board a programme of investigation which could be undertaken with a view to the improvement and development of this means of communication.

H. B. JACKSON,
CECIL L. FORTESCUE,
G. W. O. HOWE,
A. G. LEE.

O. F. Brown
(*Secretary*).

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